Contribution ID: **10** Type: **oral**

Live animal imaging & radiation therapy methods at the synchrotron

Synchrotrons provide users with unique imagining and therapeutic methods. They provide very high flux, with flat energy spectrum and quasi-coherent beam. At the same time synchrotrons are very different from clinical machines: beam is parallel and has limited size, its position is fixed and sample, together with the required live support and diagnostic equipment, has to be rotated or scanned across the beam. Scan times maybe much longer due to higher resolution and the vital signs triggering requirements. They don't normally provide a turn-key operation.

Synchrotron have proven however to be powerful tools for visualization of soft tissue as well as for functional imaging and novel therapy methods.

Phase-sensitive imaging methods exploit differences in the refractive index of tissue to enhance the contrast and imaging can be done at higher energies. They offer improved contrast sensitivity, especially when imaging respiratory system, tissue engineering samples (scaffolds) and other low contrast tissue samples such as cartilage. The high energy X-rays ensure lower radiation dose for the animals, and the high brightness reduces total time required for experiment, which is extremely important for live animal experiments and longitudinal studies. Monochromatic light provides unique options for techniques such as K-Edge Subtraction, used to visualize bone growth and development, and imaging is not affected by the beam hardening artifacts.

There are two main programs that use X-rays for cancer treatment trials: Synchrotron Stereotactic Radiation Therapy (SSRT), which uses the finely tuned monochromatic beam for localized dose delivery enhancement within the tumor mass, and micro-beam (MRT) radiation therapy, based on the spatial fractionation of high dose-rate, low energy X-rays, which promise significant advantages over conventional clinical techniques for some diseases if successfully transferred to clinical practice.

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Track Classification: Small animal imaging and therapy